ScienceDesk Project Overview

Ames Research Center

ScienceDesk Team

Rich Keller (PI)
Jim Chen
Kim Hubbard
Deepak Kulkarni
Shawn Wolfe

Jon Guice

Computational Sciences Division

NAI Early Microbial Ecosystems Research Group (EMERG)

Dave Des Marais
Brad Bebout
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Tori Hoehler
Scott Miller
Linda Jankhe
Chris Raleigh

Exobiology Branch & NAI

Electron Microscope Team

Dave Blake
Lee Bebout
Kathy Kato
Sherry Cady
Lori Crumbliss

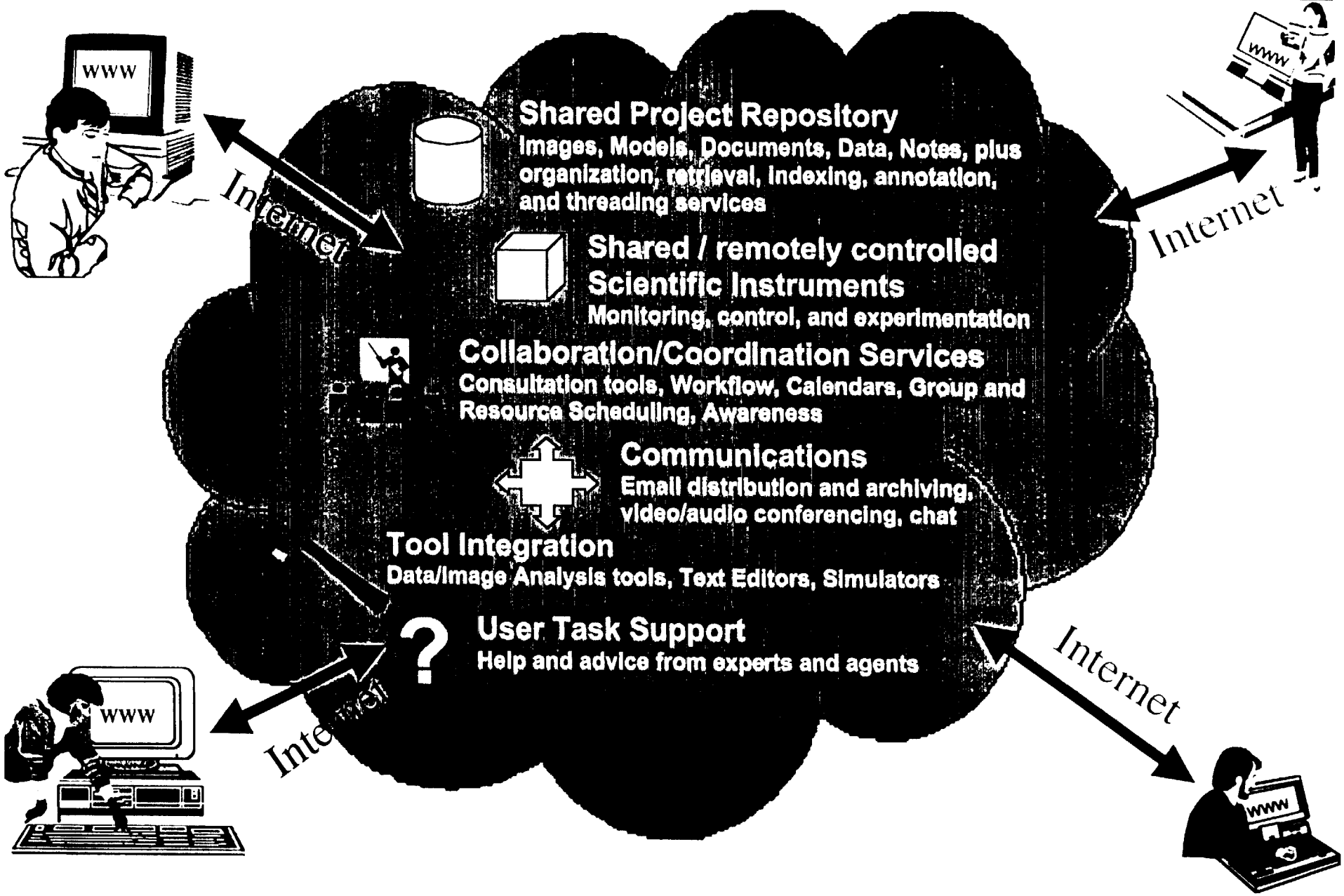
Exobiology Branch

NASA Ames Research Center

Funded by: CETDP, NAI, IS

ScienceDesk Charter: Infrastructure support for distributed scientific teams

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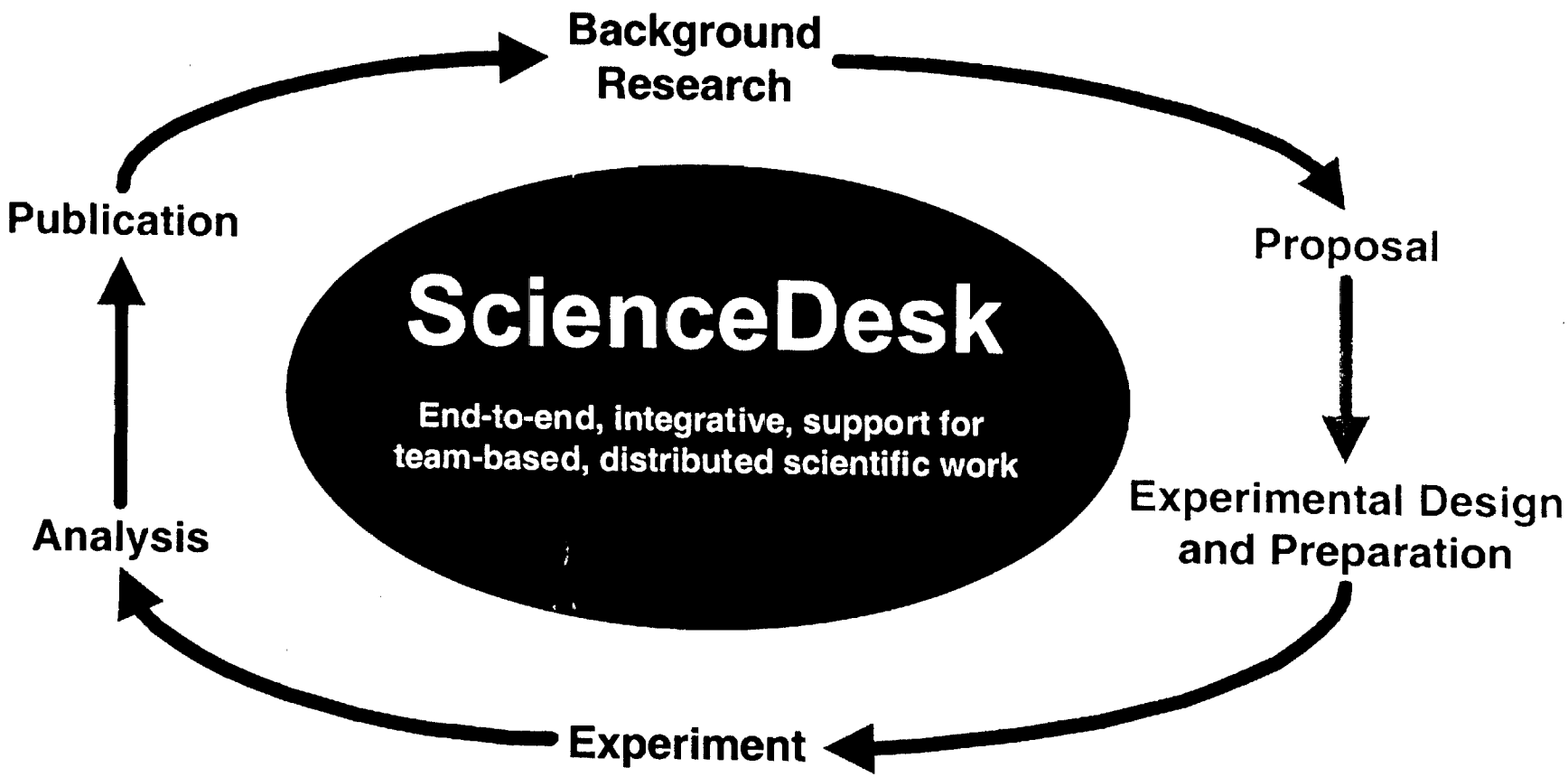


Specific Research Focus



- **Scientific Knowledge Management:** capture, preservation, traceability of scientific knowledge
- **Information Access:** intelligent indexing and visualization
- **Collaboration:** asynchronous and synchronous science teamwork
- **Semi-autonomous Remote Experimentation:** intelligent monitoring and control

Lifecycle Support for Scientific Teams



ScienceDesk Motivation

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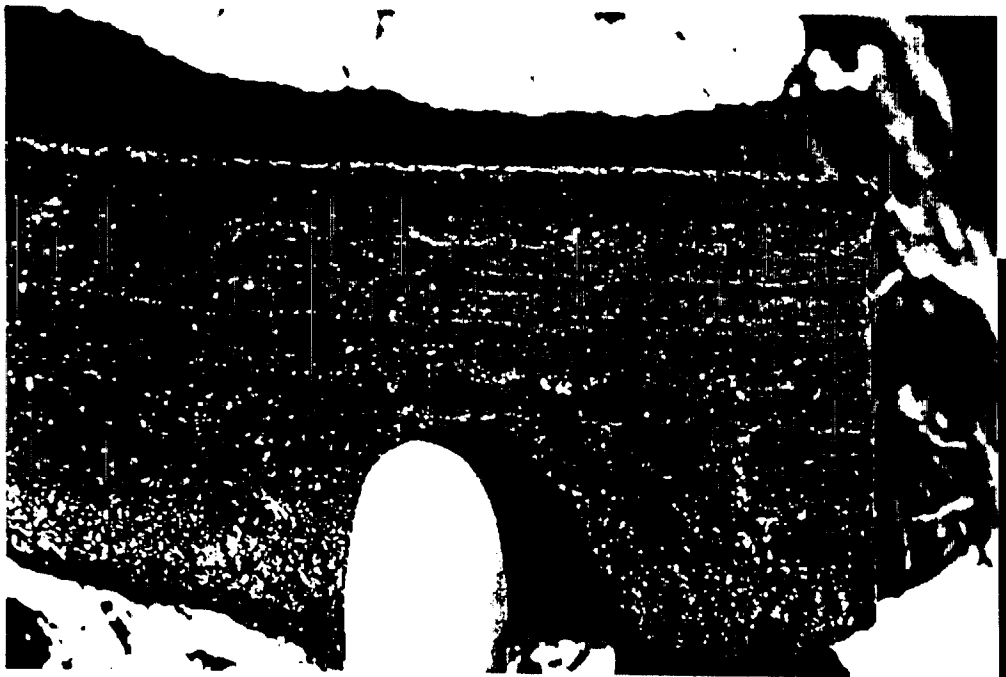
- **Critical nature of scientific work:** essential for success of NASA missions cross-enterprise, yet little infrastructure support
- **Inevitability of distributed work:** conducted in offices, labs, field, spacecraft using multi-person, cross-institutional teams; remote collaboration and information sharing is essential
- **Inadequacy of scientific recordkeeping:** a logistical nightmare with multiple media and formats; difficult and tedious, resulting in inefficiencies, irreproducibility, dissemination failures, and "organizational amnesia"
- **Limited scientific resources:** Valuable, one-of-a-kind resources must be shared electronically:
 - information & data on rare samples (moon rocks, Mars meteorite)
 - expensive instruments (electron microscopes, gas chromatographs)

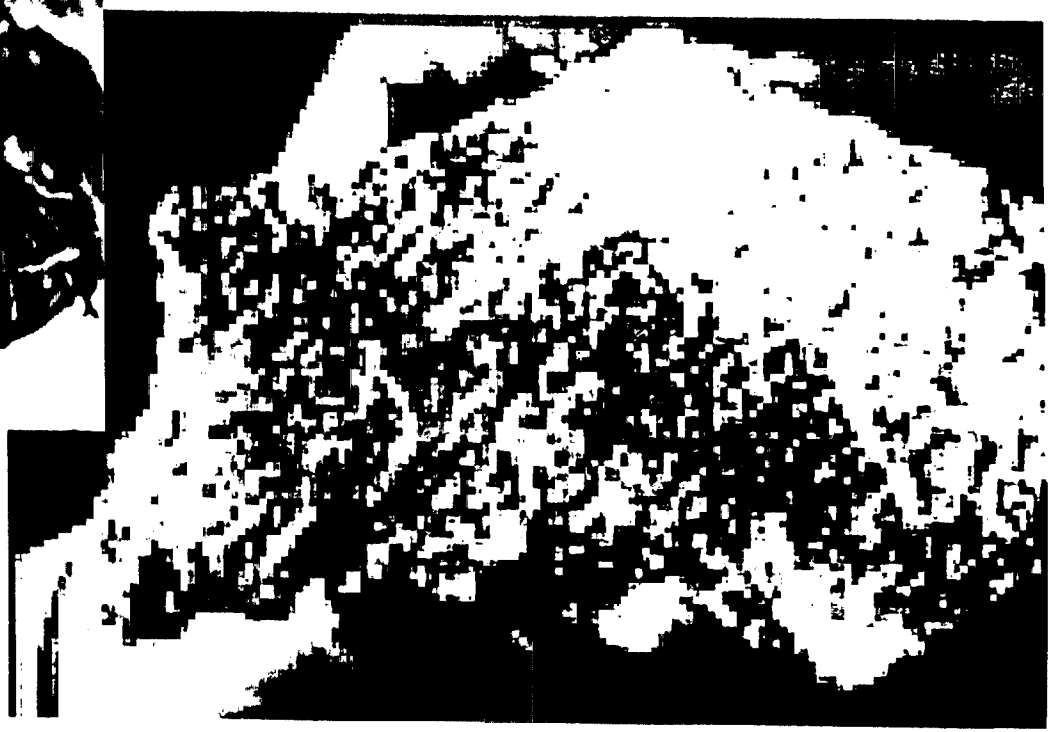
ScienceDesk Testbed: Early Microbial Ecosystems Research

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Study of "Microbial Mats"

- Photosynthetic microbial mats are the oldest known ecosystem on Earth
- Can be found in extreme environments (thermal, saline, high carbonate)
- Serve as an early-Earth analog for studying development of life





Early Microbial Ecosystems Group: Distributed Field and Lab Work

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Field Research Sites

Home Institutions

Field Data Collection & Preliminary Data Analysis

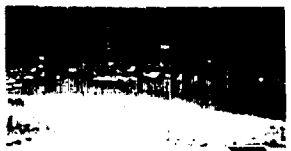
Portland State

U. of Oregon

U. Conn

U. Miami

Arizona State



Highborne Cay, Bahamas



Baja California, Mexico

Field Samples

Geological Samples



Yellowstone National Park

Biological Samples

Microscopy Lab



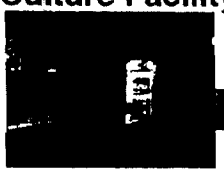
Greenhouse



Microbiology Lab



Microbial Culture Facility



Other culture collections

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Microbial Cultures

Human-Centered Methodology

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Study science team in operation

- interview
- observe (lab & field)
- videotape

Participatory design & partnership

Analyze and model

- workflow
- procedures
- communication flow

Develop new IT concepts & tools

- ScienceOrganizer
- Shared Image Annotator
- O_2 Microsensor Controller

Develop prototype

Evaluate prototype

Critique & Review

Critique & Review

Critique & Review



Bottlenecks Observed



- Information sharing, management
- Information tracking
- Historical preservation, replication of results
- Access to scientific instruments & facilities
- Scientific consultations
- Remote experimentation

Four ScienceDesk Development Thrust Areas

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Portland State
U. of Oregon
U. Conn
U. Miami
Arizona State

Field Research Sites
Home Institutions


Highborne Cay, Bahamas

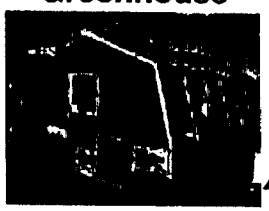

Baja California, Mexico

1. Project Info. Repository
- Images
- Cultures
- Datasets
- Procedures
- Documents
- Scientific Records

2. Remote Electron Microscopy Facility


Yellowstone National Park

Microscopy Lab


Greenhouse


3. Greenhouse Collaboratory

4. Cyanobacteria Culture Collection

Microbiology Lab


Microbial Culture Facility


Thrust 1:
Project Information Repository

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- Create centralized repository for project information:
 - documents
 - datasets
 - images
 - scientific records
 - procedures
- Facilitate linkages between related information
- Establish "Nerve center" for team's knowledge and data management activities

Tool developed: *ScienceOrganizer*

ScienceOrganizer:
A threaded scientific repository

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Netscape: Science Organizer: HBC-2

ScienceOrganizer: An Information-Sharing Tool For Scientific Project Teams

New Item | Search | Home | Logout

Links for Current Item:

Culture: HBC-2

Add Links | Remove Links

- Cultivated From
 - Stromatolite
- Has Genetic Sequence Info
 - HBC-2: 16S rRNA sequence
- Has Growth Medium Recipe
 - ASN Medium Recipe
- Has Image
 - HBC-2: Image
 - HBC-2: Image (jpeg)
- Has Maintenance Medium Recipe
 - ASN Medium Recipe
- Isolated By

Info for Current Item:

Culture: HBC-2

Modify Current Item | Enclose Current Item | Delete Current Item

Notes: isolated from caramel layer, stromatolite beach, Highborne Cay, 6/97

Description | Cultivation Data | Collection Information | Isolation Data | Top of Page

Description

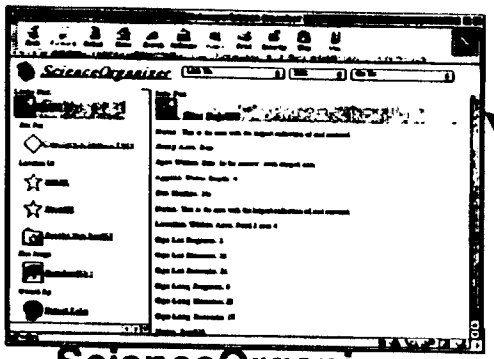
Genus-Bergey's:	unknown
Genus Status:	Tentative
Species:	
Strain Number:	
Alternative Names:	Phormidium Schizothrix
Cyanobacteria Length (μ):	1
Cyanobacteria Width (μ):	1

Physiology

N2 Fix:	Unknown
Motility:	Unknown
Salt Tolerance:	Marine
Heterotrophic:	Unknown

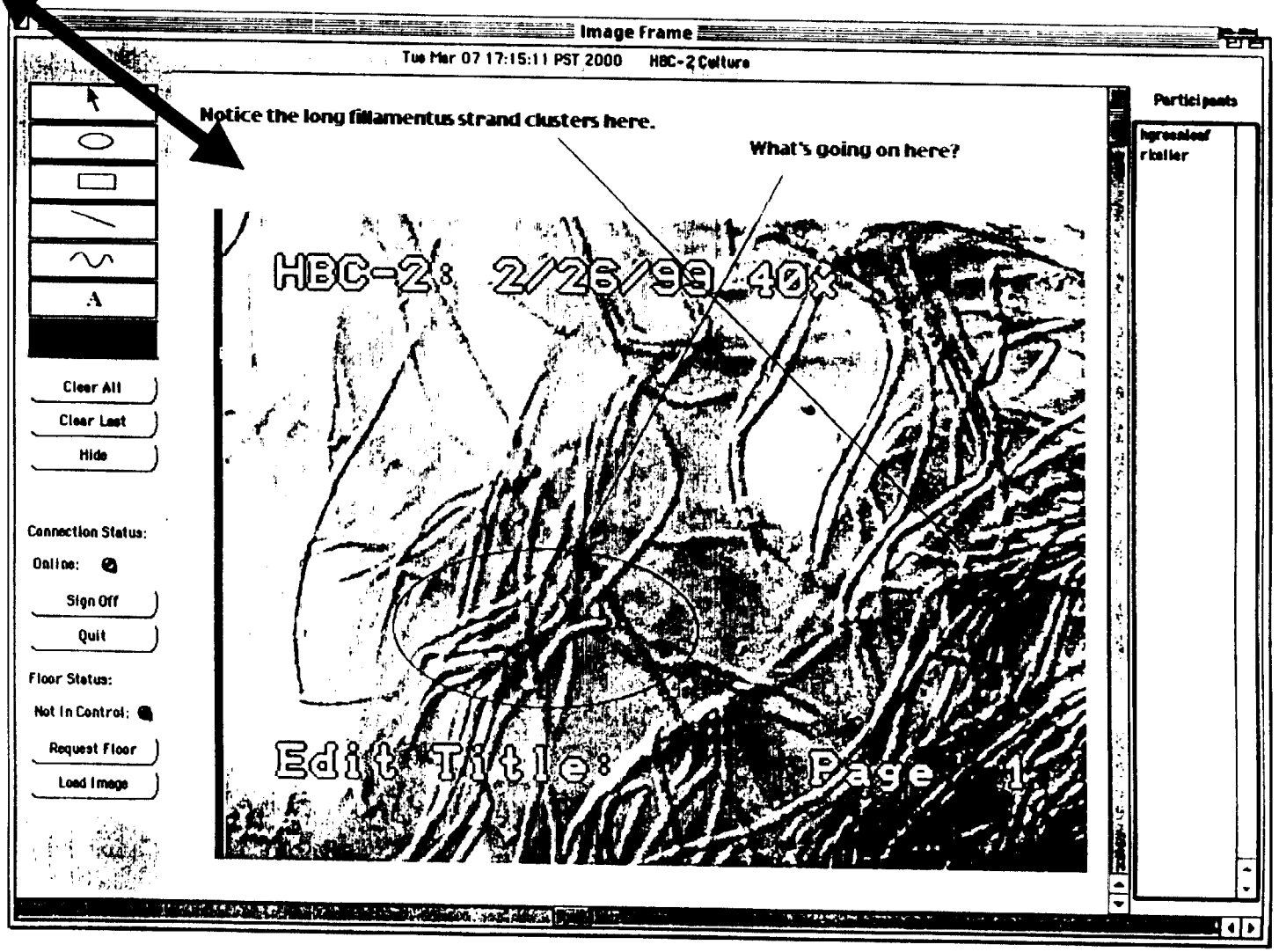
Auxiliary tool: Shared Image Annotator

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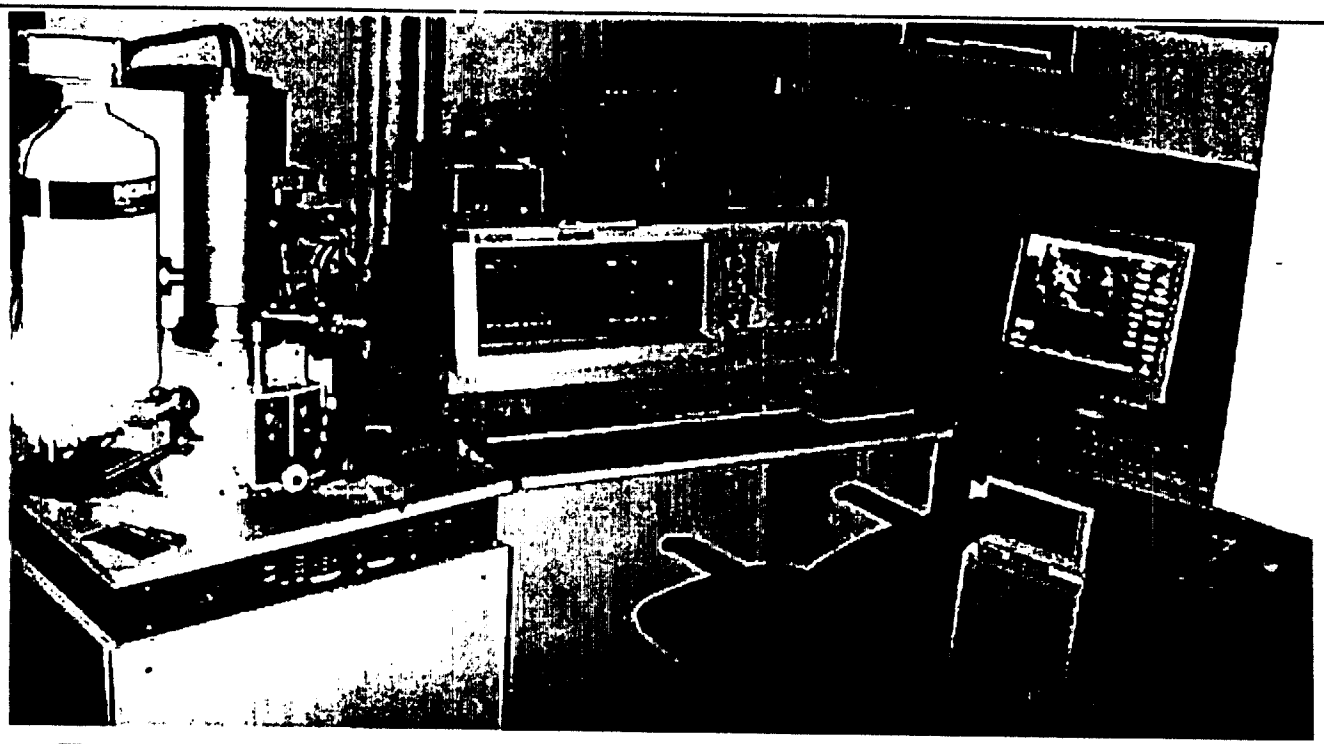
ScienceOrganizer

Collaborative Whiteboarding & Annotation Tool



Thrust 2: Remote Electron Microscopy Facility

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- Remote control of electron microscope
- Enable collaborative image annotation & consultation
- Webcam and Timbuktu for collaboration support
- EM images stored in ScienceOrganizer repository
- Recent collaboration with NREN & NAI

Tool developed: *Shared Image Annotator*

Remote Microscopy Architecture

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Digital Micrograph

image acquisition

Scanning Electron Microscope (SEM)

Remote Stage

remote stage control

SEM Control Computer

ScienceOrganizer

images

Timbuktu

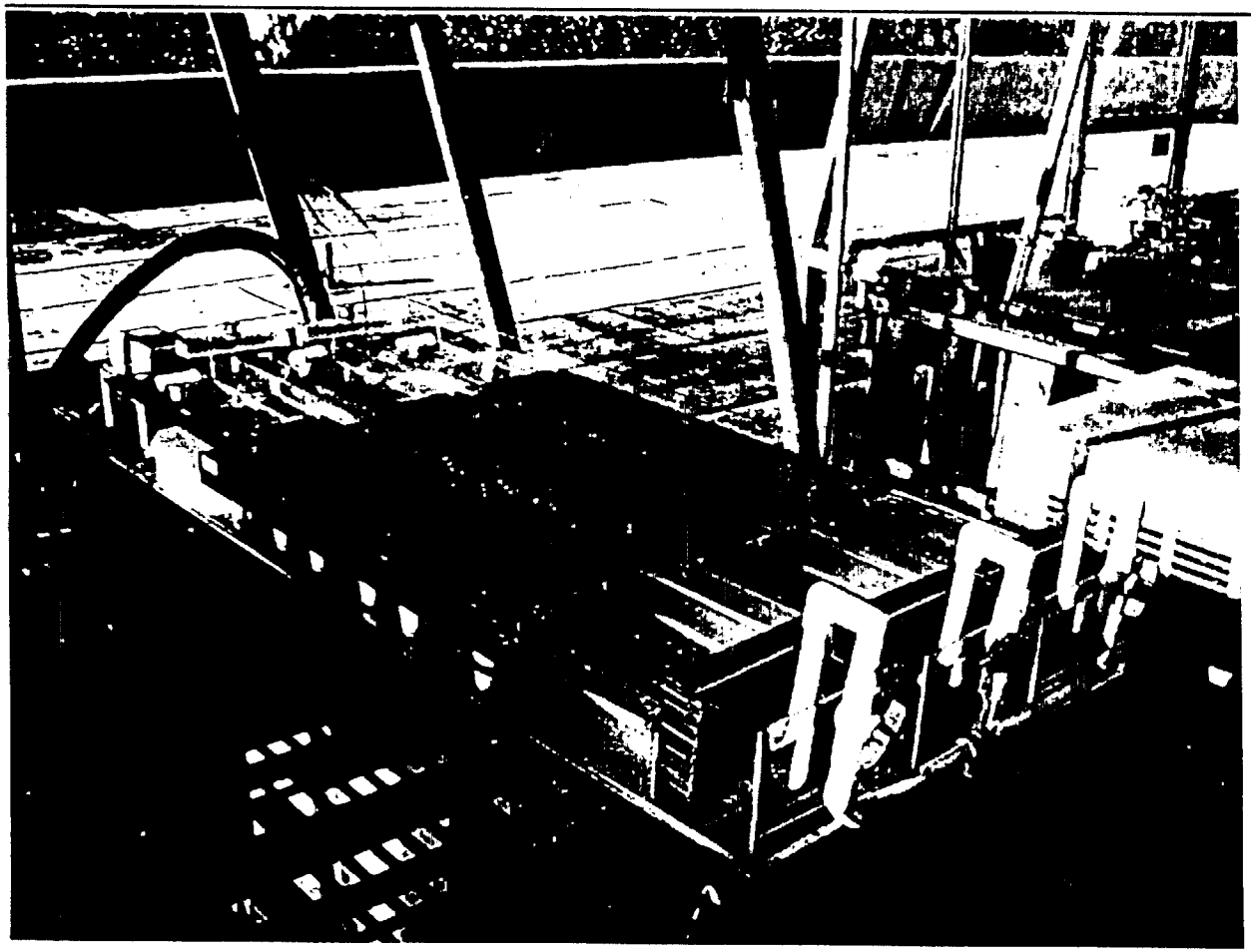
ScienceDesk Server

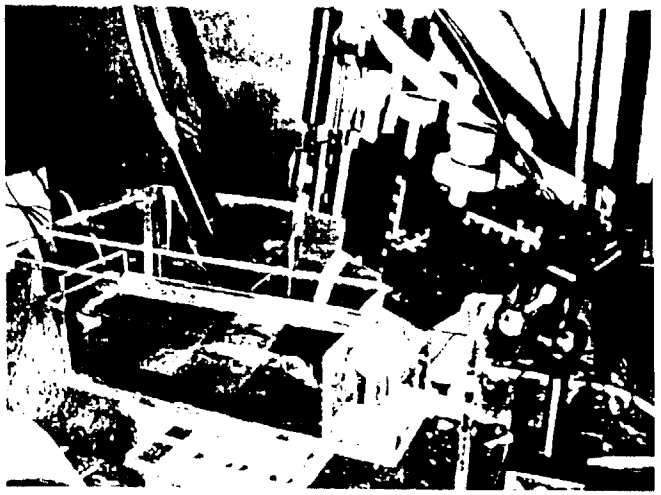
Remote User



Thrust 3:
Greenhouse Collaboratory

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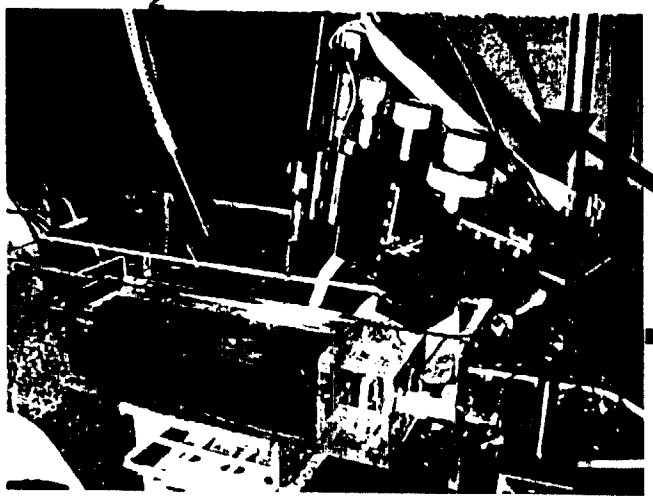
- Synchronous control and monitoring of scientific instruments
- Experiment planning and protocol mgmt
- Intelligent agents
- Integration of acquired data into ScienceOrganizer

Tool developed:
Microsensor Controller
(a.k.a. "Matsticker")

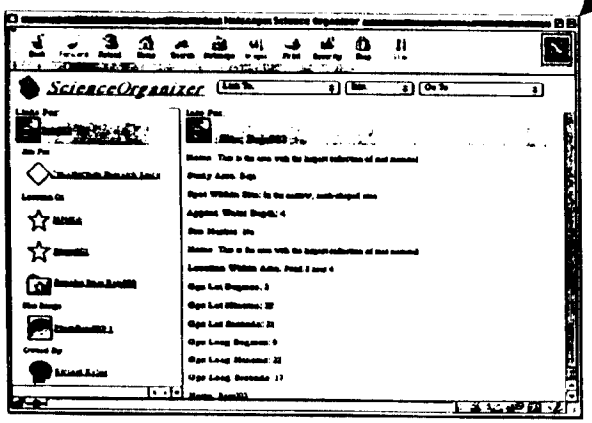
Remote Experimentation:
Oxygen Microsensor Remote Controller

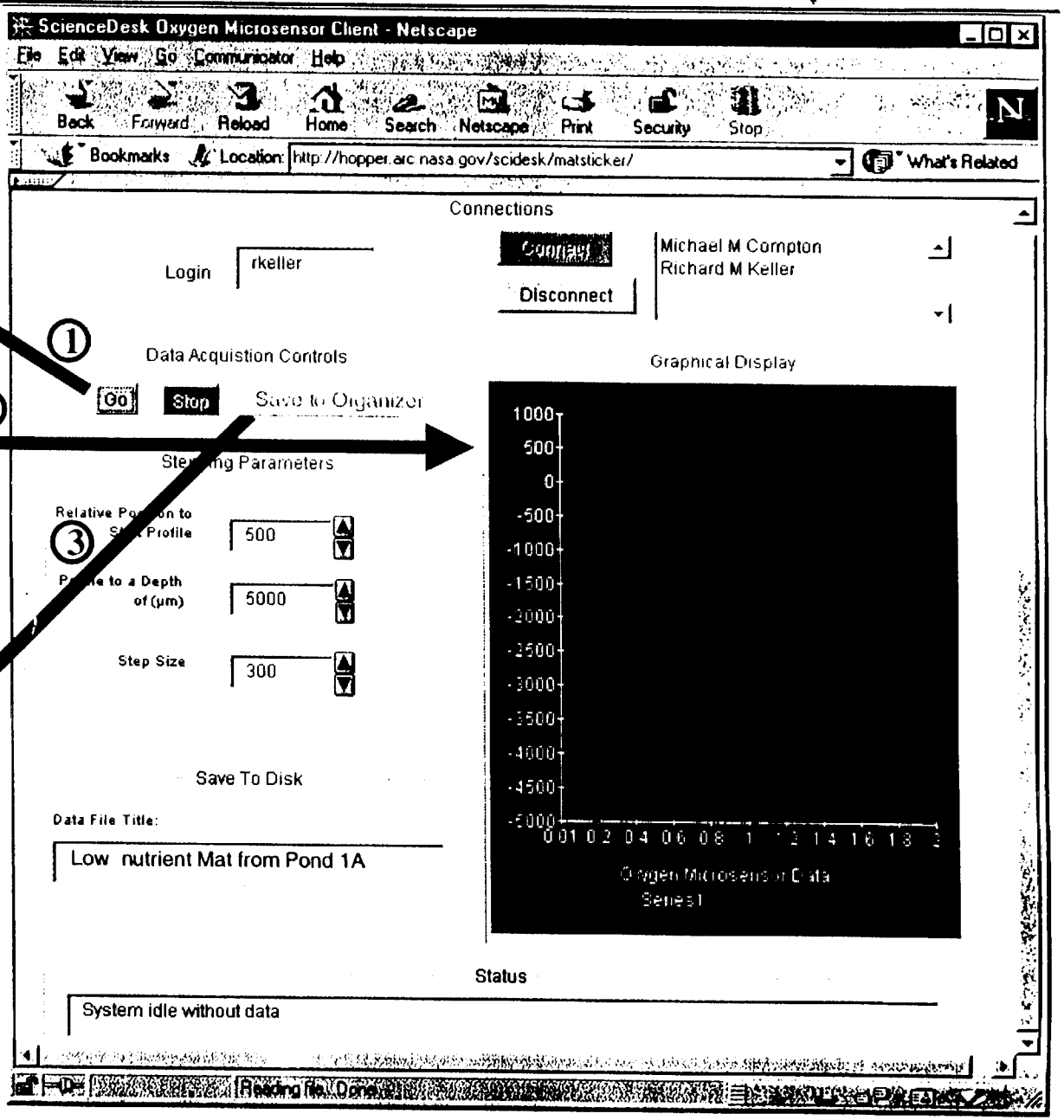
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O_2 Microsensor

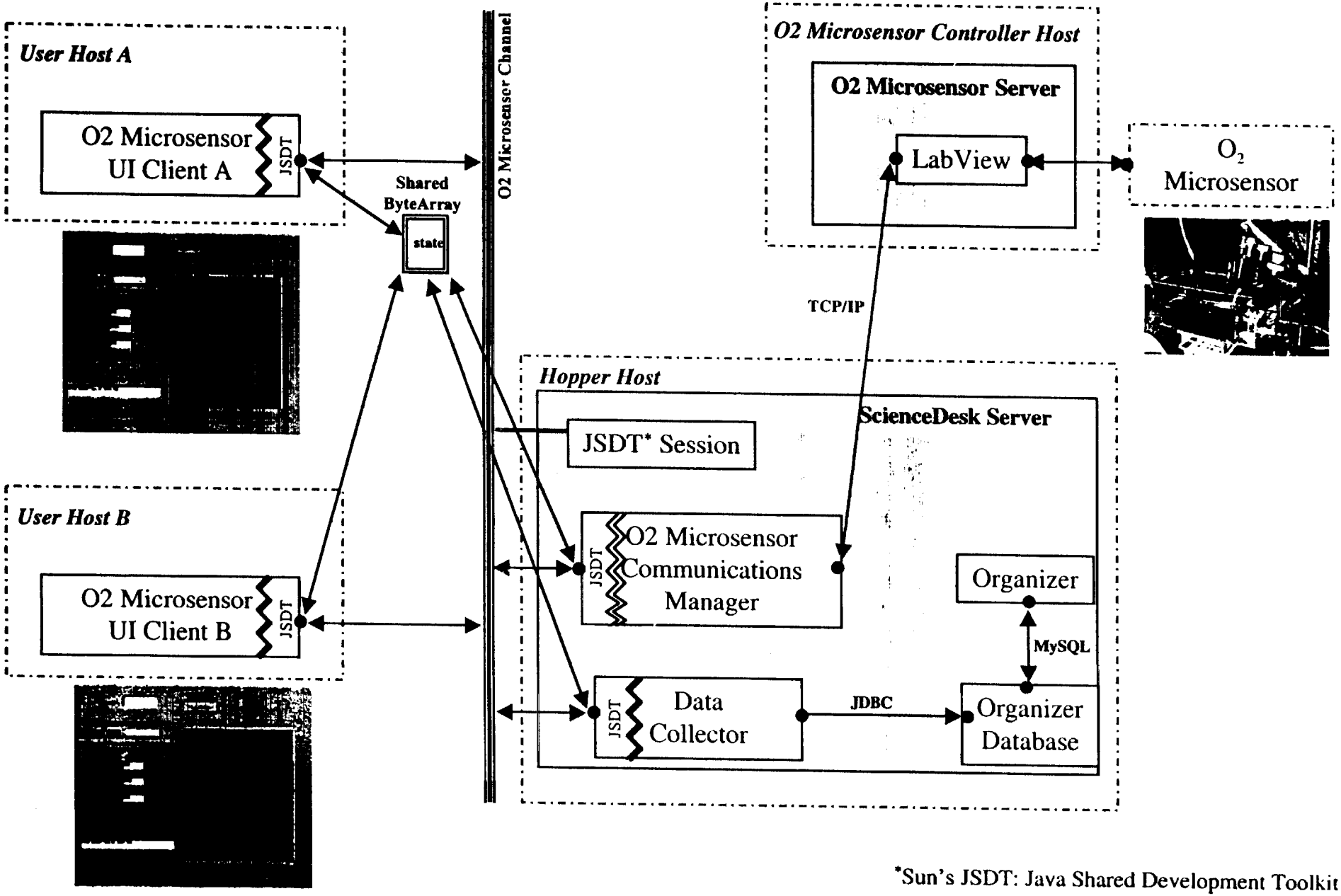


ScienceOrganizer





O_2 Microsensor Control Configuration

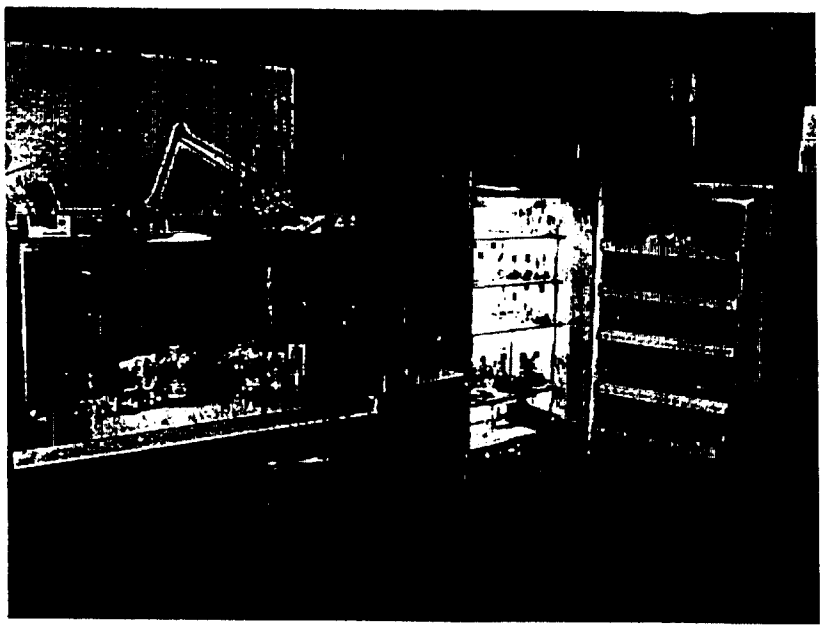


*Sun's JSDT: Java Shared Development Toolkit

Thrust 4:
Cyanobacteria Culture Collection

Information Sciences & Technology
Ames Research Center

- Specialized repository for microbial cultures
- Electronically "Housed" within ScienceOrganizer
- Linkage between organisms' metabolic functioning and collection environments
- Searchable based on detailed criteria
- Possible linkage with Univ. of Oregon collection



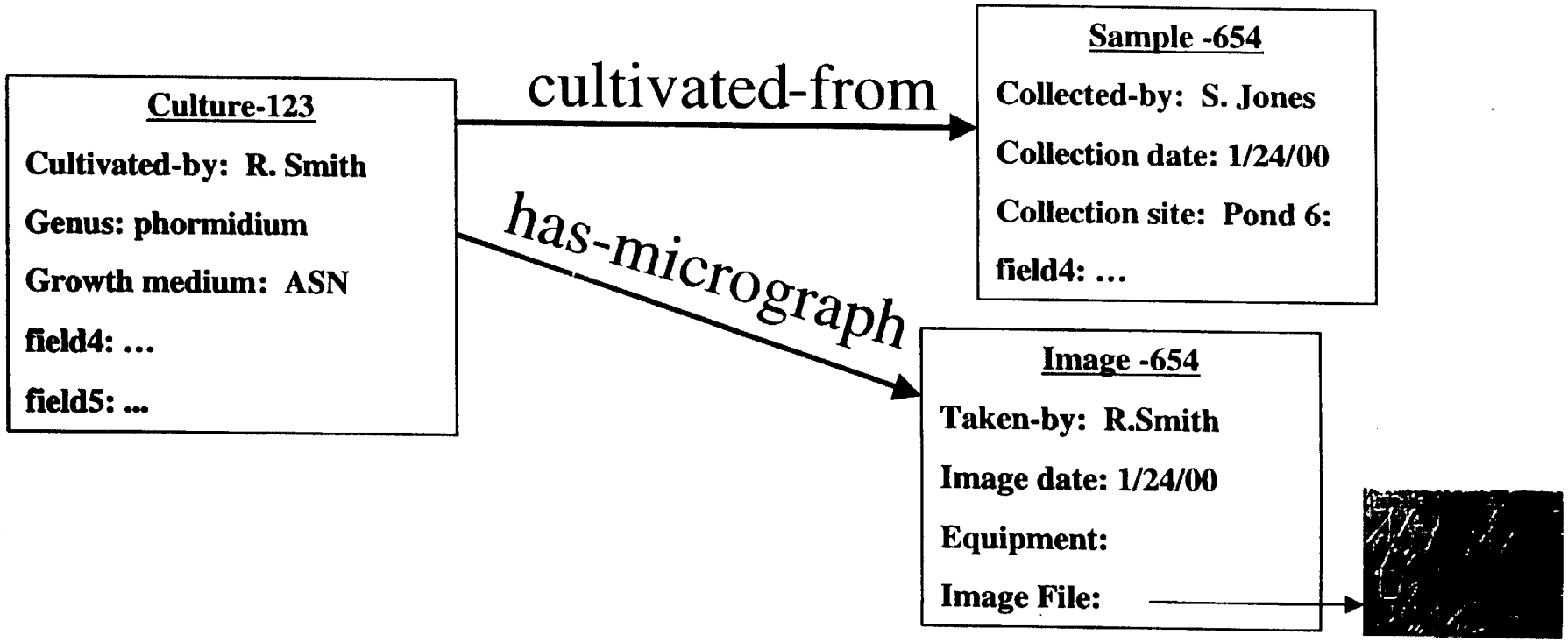
Capability Developed:
Ames Exobiology Culture Collection (within ScienceOrganizer)

ScienceOrganizer Primer

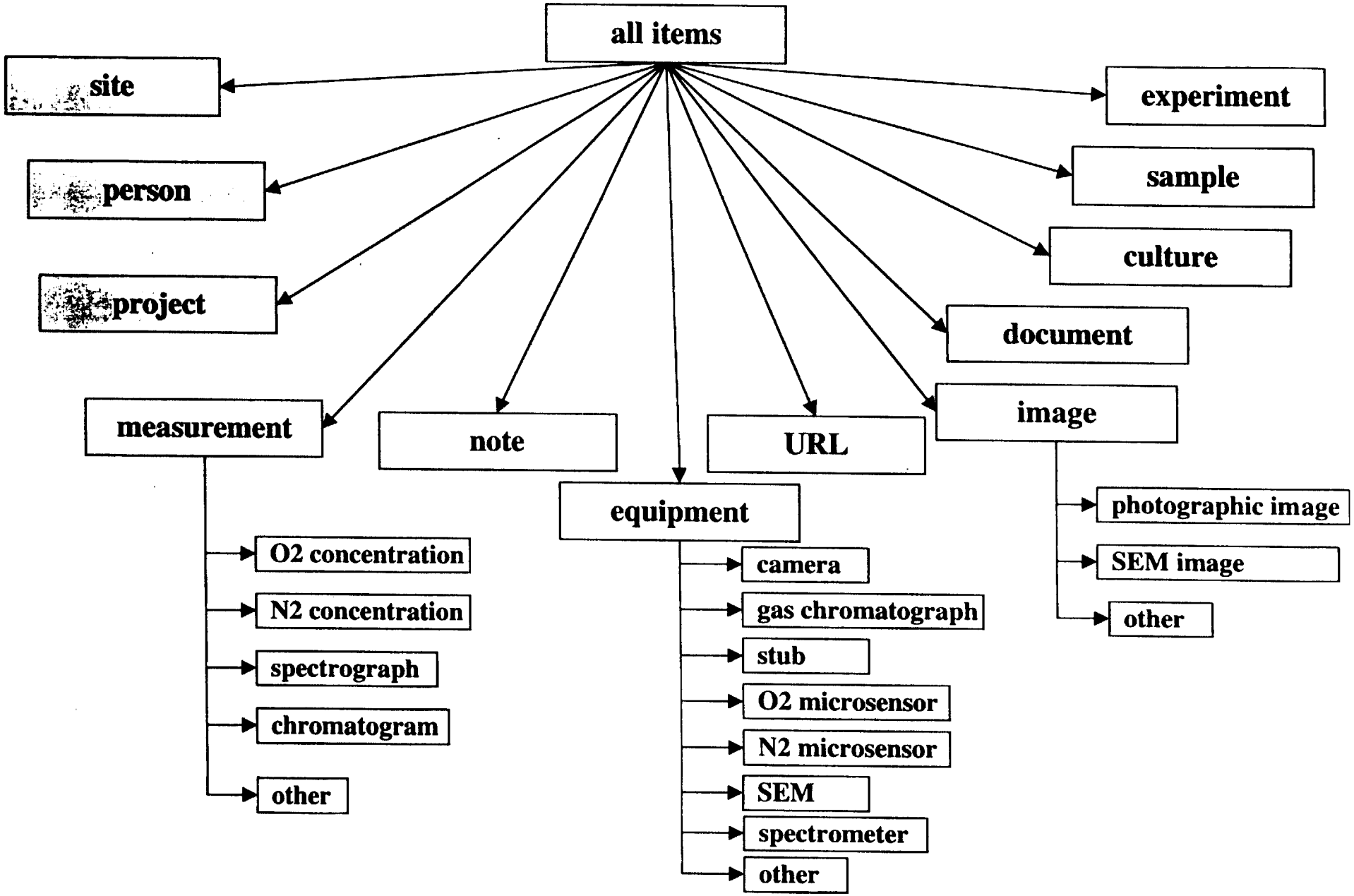
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Purpose: Enter, interlink, and subsequently access scientific project information

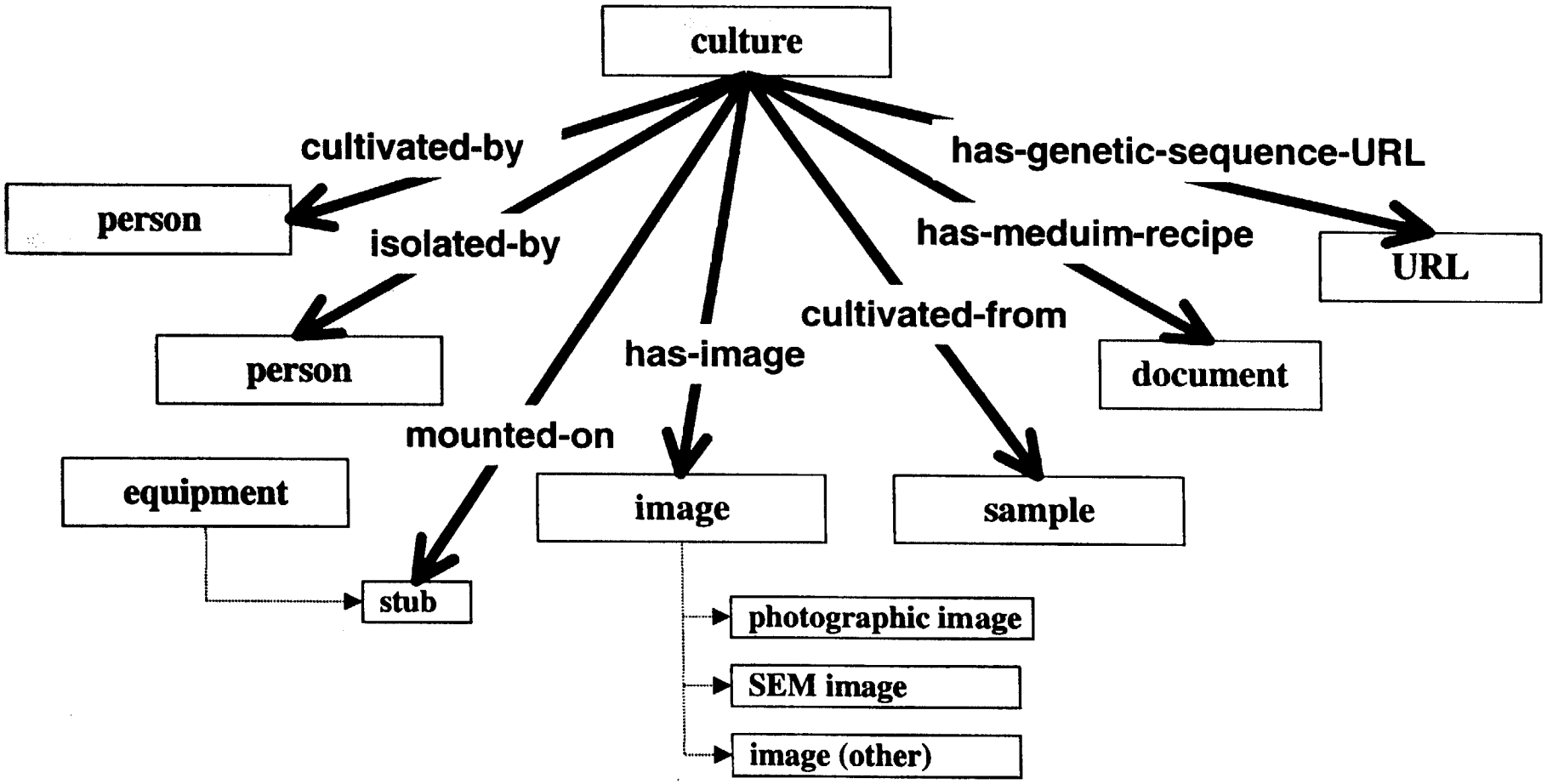
- Information Items (e.g., scientific records, images, documents, measurements)
 - Contain text or numeric fields
 - Have attached files (e.g., Word, Excel, dataset)
- Links can be created between Items



Types of ScienceOrganizer "Information Items"

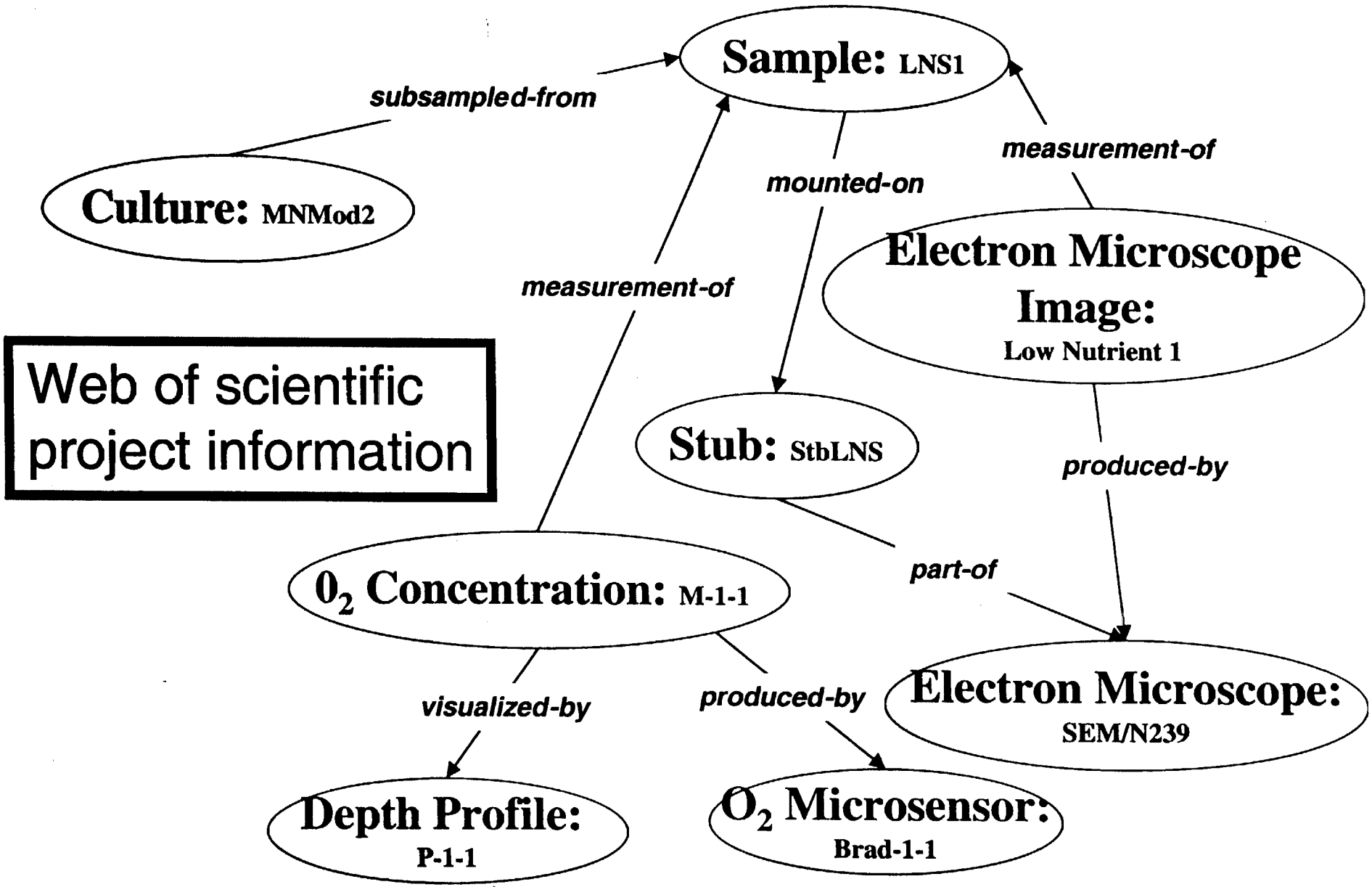


Sanctioned Links between Items



Semantic Relationships among Scientific "Information Items"

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Project Status



FY'99 Achievements:

- Strong partnership with Exobiology branch and Astrobiology Institute
- Design and initial implementation of ScienceDesk tools (ScienceOrganizer, Microsensor Remote Controller, and Shared Image Annotator)
- Initiation of user testing for two of these tools

FY'00 Goals:

- Integration of three tools
- Construction of Cyanobacteria Culture Collection within ScienceOrganizer: first actual testbed for ScienceOrganizer usage
- Enable user customization and configuration facilities



Technical Challenges & Opportunities



- Automated knowledge capture: ease user burden
- Customization facilities: content and organization
- Balance between structure and flexibility
- Novel input modes (speech, pen)
- Mobil/wireless settings
- Agent-based experiment monitoring



Characterizing ScienceOrganizer



Related tools:

- Document-sharing systems: Postdoc, BSCW, DocuShare
- Electronic notebooks
- Laboratory information mgmt. systems (LIMS)
- Personal information mgmt. systems (PIMS): MS Outlook, Palm Organizer

Distinguishing features:

- Structured, domain-specific information space:

 facilitates access and cross-project sharing

- Configurable and customizable
- Information threading to interrelate information and facilitate navigation
- Combination document repository and database
- Intelligent model-based behavior

 facilitates inference

Scientific Information Items:
- sites
- samples
- images
- proposals
- measurements
- cultures
- graphs
- consultations
- participants
- stubs



Augmentations beyond Postdoc



- **Repository contents:** includes threadable, customizable scientific records
- **User interface:** two-section display featuring items and links
- **Navigation:** users navigate via threaded links or hierarchically
- **Information modeling:** contains a semantic model of interrelationships among different types of scientific information
- **Auxiliary tools interface:** Shared Image Annotator and Microsensor Remote Controller

ScienceDesk Overview 5/99

ScienceDesk Team	Electron Microscope Team	NAI Microbial Ecosystems Group
Rich Keller	Dave Blake	Dave Des Marais
Kim Hubbard	Lee Bebout	Brad Bebout
Dennis Heher	Kathy Kato	Tori Hoehler
Larry Kiser	Sherry Cady	Kathleen Londry
Jon Guice	Lori Crumbliss	Lee Bebout
		Linda Jankhe
		Chris Raleigh
		Pam Reid

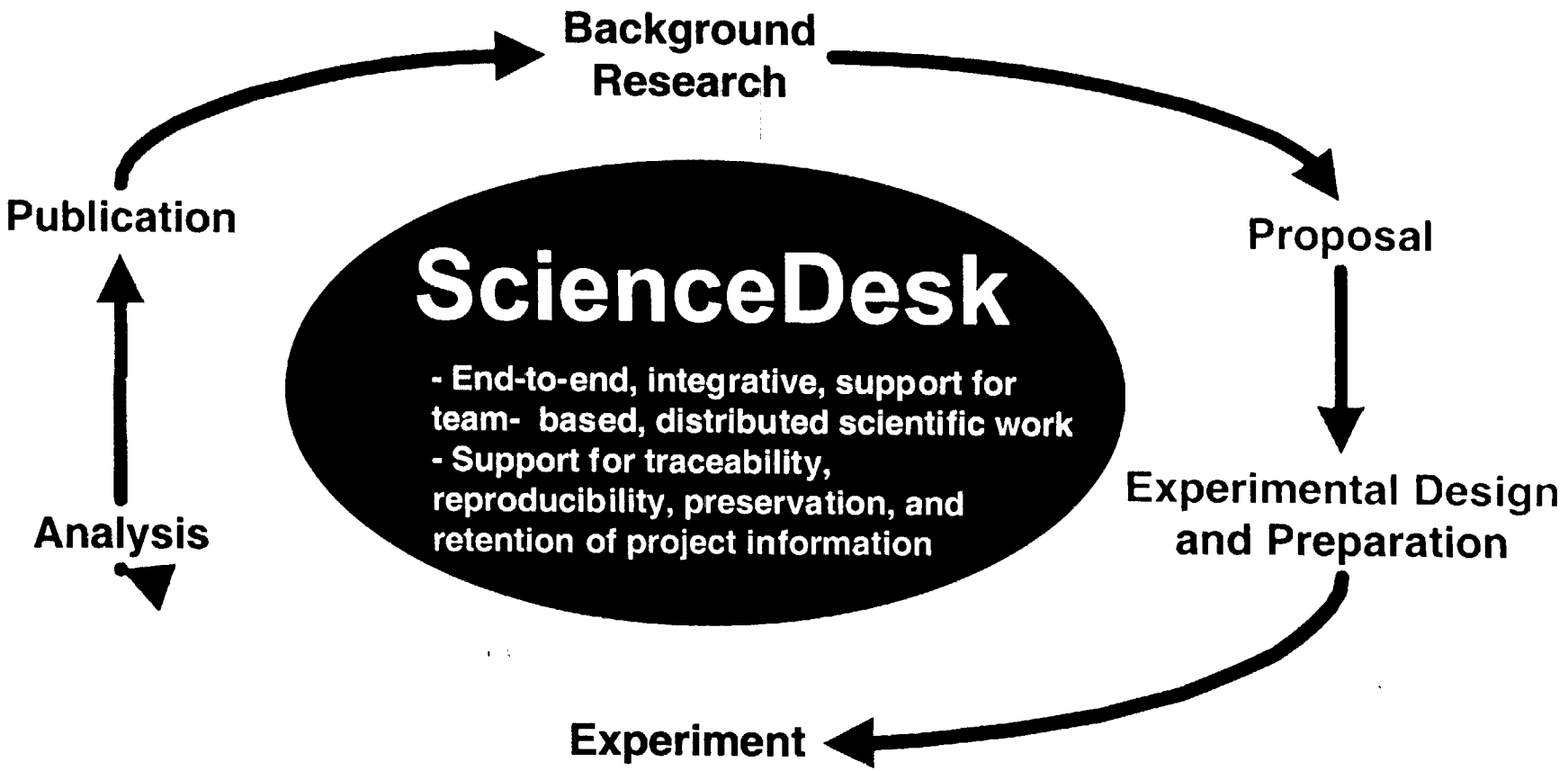


NASA Ames Research Center

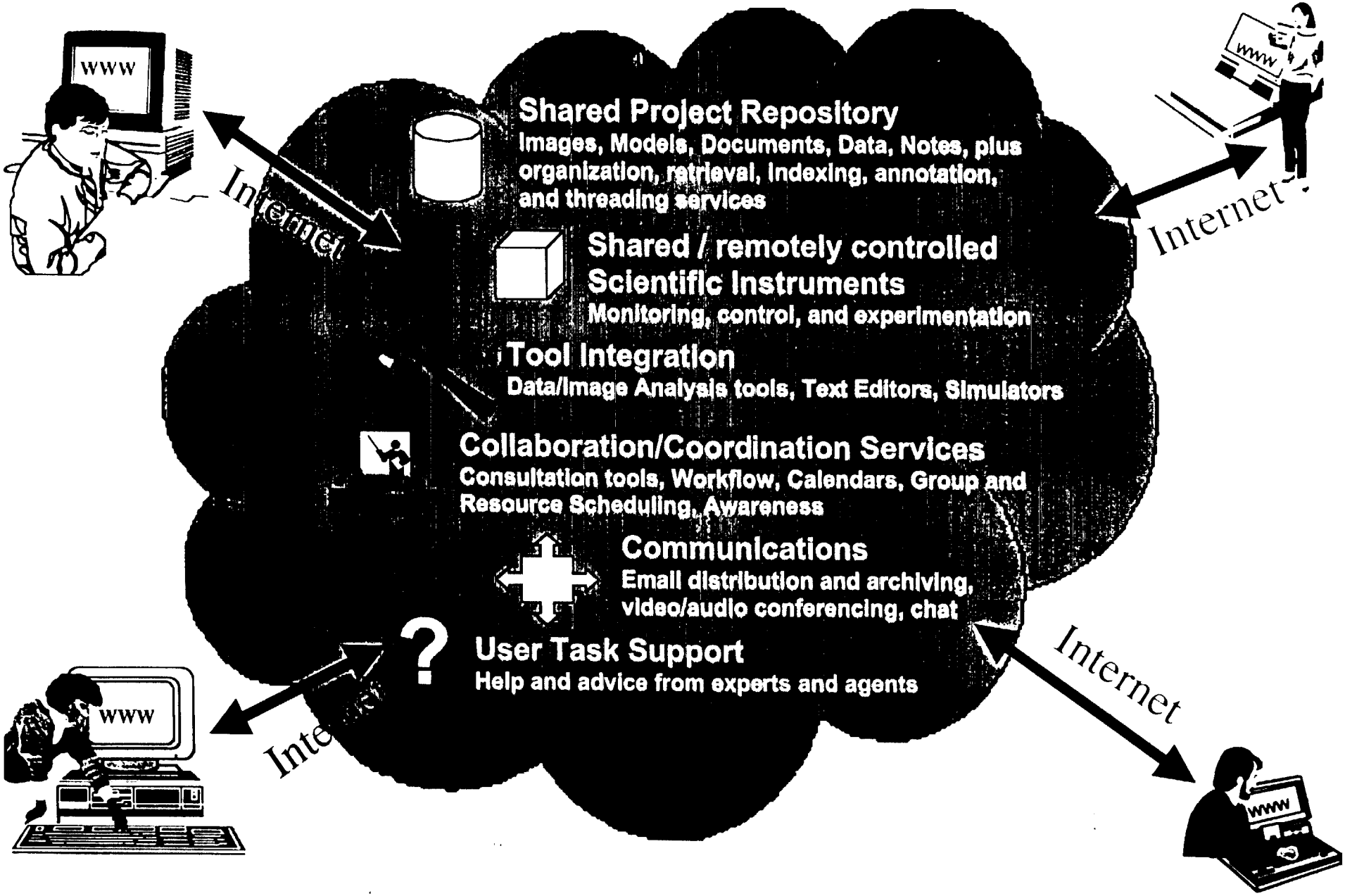


ScienceDesk Focus

"Lifecycle infrastructure support for collaborative science teams."



ScienceDesk: Support for Collaboration, Knowledge Management, and Remote Experimentation



Tool Development in Progress

1. ScienceOrganizer

- Centralized repository for project info; knowledge and data mgmt. activities
- Central access point for science tool utilization; science workflow mgmt.

2. Consultation Tool

- Consultation setup and session management
- Synchronous collaboration with image sharing and annotation
- Consultation notes maintenance

3. Remote Experimentation Tool

- Synchronous control and monitoring of scientific instruments
- Experiment planning and protocol management

Science Organizer

Projects | Sites | People

◇ Project: Martian Fossils Study

Project nickname: mars-fossil

Description: Study evidence for Martian fossils in ALH84001 meteorite. Examine morphological and minerological features that have been attributed to life

PI: Lee Prufert-Bebout

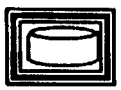
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Participants
Updated 2/15/99 14:05 by System



Cultures
Updated 2/15/99 14:05 by System



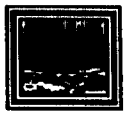
Stubs
Updated 2/15/99 14:05 by System



Measurements
Updated 2/15/99 14:05 by System



Samples
Updated 2/15/99 14:05 by System



Sites
Updated 2/15/99 14:05 by System



Images
Updated 2/15/99 14:05 by System



Consultations
Updated 2/15/99 14:05 by System

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Martian Fossil DDF Proposal

Updated 2/15/99 14:07 by Lee Prufert-Bebout

Science Organizer

Projects | Sites | People

up to Project Martian Fossils Study
up to Samples

Sample: LNS1

Project: Martian Fossils Study

Sample descriptor: Low nutrient sample
System label: S-1-1
Culture: MNMOd2 (C-1-4)
Prepared by: Lee Prufert-Bebout on 3/1/99 12:02
Notes: This sample is the first one to be examined with the low nutrient concentration.
Coated/Mounted by: Lee Prufert-Bebout on 3/2/99 14:44
Coating type: Aluminum

Edit

Associations: Add | Delete | Cut | Paste

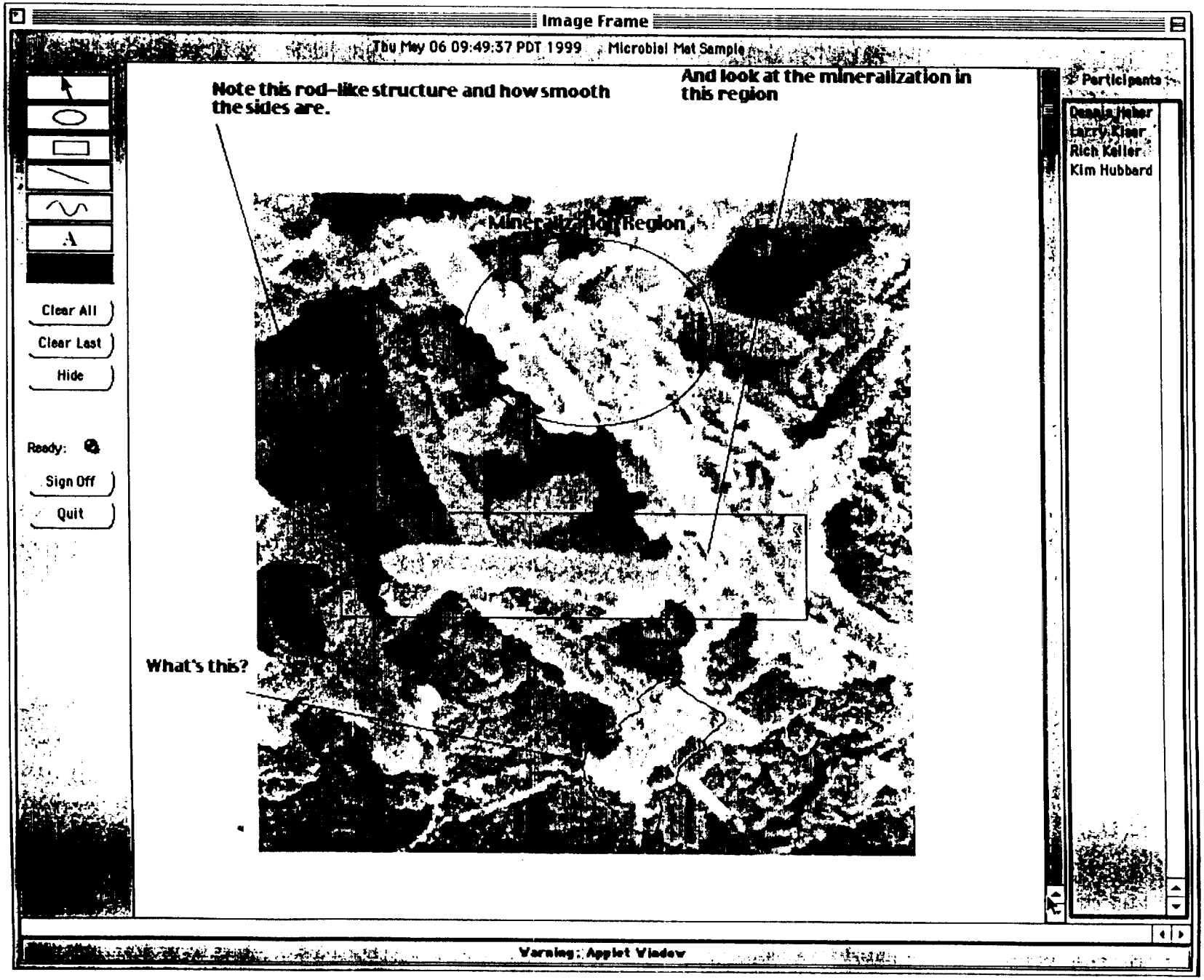
Updated 2/18/99 16:28 by Lee Prufert-Bebout
Culture MNMOd2 (C-1-4)

Updated 3/2/99 16:02 by Lee Prufert-Bebout
Stub StbLNS (Stb-1-1)

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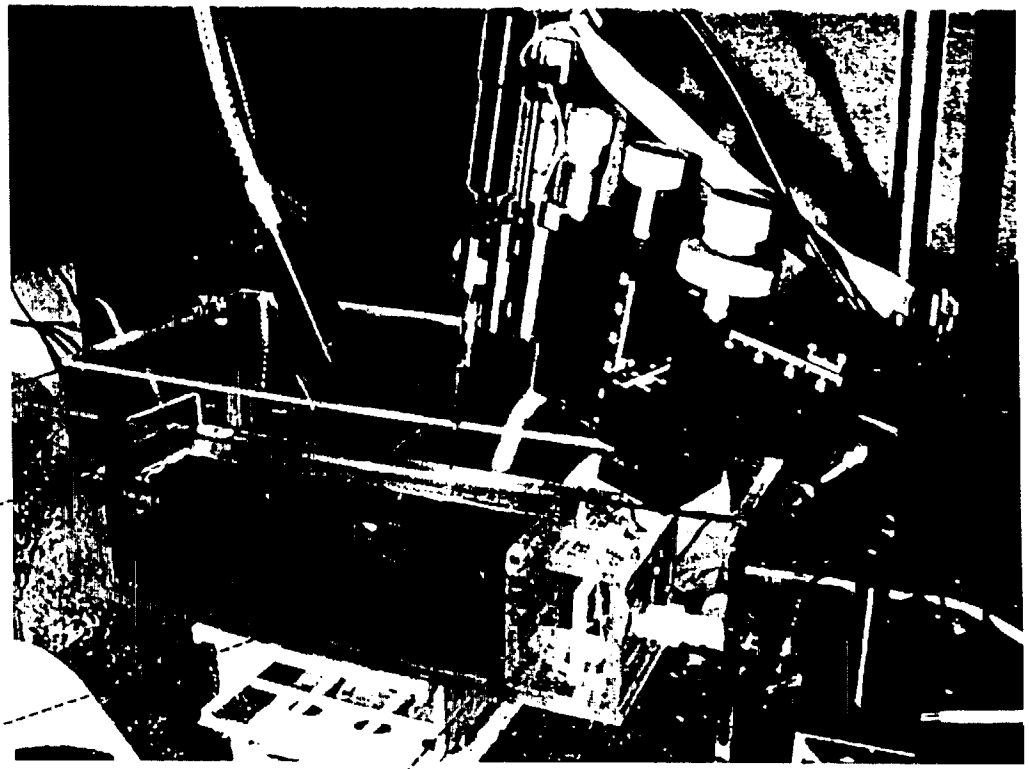
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Shared Image Annotator



Oxygen Microsensor Apparatus

Brad Bebout, Code SSX





Motorized sensor pierces microbial mat, pausing to take 02 readings at specified depth intervals

Oxygen Microsensor Remote Controller

